A METHOD TO EVALUATE INVESTMENT PROJECTS IN INDONESIAN DEFENCE INSTITUTIONS

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A METHOD TO EVALUATE INVESTMENT PROJECTS
IN INDONESIAN DEFENCE INSTITUTIONS

by

Thomas Jappy Kakiay

March 1980

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Submitted In Partial Fulfillment Of The

Requirement For The Degree Of

ABSTRACT

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I. INTRODUCTION

In pursuing government objectives and particularly those of the Department of Defence, investment and resource allocation problems arise during the formulation of procurement policies and the planning of future force composition. To evaluate investment for any project it is necessary to deal with investment criteria. The investment planner postulates the alternative means for any project and then decides among these alternatives by looking at costs for constant benefits. To precisely determine the benefits concerned with the procedures to facilitate the objective:

1. Define the relevant benefits
2. Determine the sources of information on benefits
3. Collection of information
4. Evaluation and representation of benefits.

The most important problem in evaluating Department of Defence investment projects is that not enough information is available on the benefits of the project. In addition to dealing with this problem of non-available information it is convenient to concentrate on determining the cost of any project. The decision to choose any alternative of defence institution investment project must be concerned with the system of cost and benefit:

1. Investment Criterion
2. Input Cost Structure

3. Cost Estimation Relationship Method

4. Capital Budgeting Method.

In comparing the alternatives among defence investments we are concerned with either finding the lowest cost by minimizing the objective function of cost subject to the effectiveness constraint at all given periods of time, or maximizing the measure of effectiveness subject to the cost constraint for all given periods of time. In the last chapter an example will be given for each method that will be concerned with the investment criterion, input cost structure, cost estimation relationship method and capital budgeting method.

II. METHOD TO EVALUATE INVESTMENT PROJECTS

A. INTRODUCTION

To evaluate investments for any project it is necessary to deal with the content of that project as was determined by its purpose. For instance, to build a ship needs X ton of steel and Y electrical generators and other items. In project analysis it is convenient to analyze these aspects of a project as follows:

1. Management

Managing a project, which may take many years to complete and put together its various elements, requires a high degree of organization. Material and equipment have to be ordered to arrive on schedule. Many of the defence investments need skilled managers and technicians. As an example, for investment in a ship, it is required to analyze the position of the Navy district and base to know and support the operating ship. On the other hand, there are projects which only require managers skills of a fairly low level of sophistication but in a large number, for example: to build a lot of housing components in every district of the Armed Forces, needs many managers/officers qualified in this field.

2. Policy Aspect

In the project investment cases the framework of economic policy is usually taken as given. If policy is not optimal correction must be made. Policy is enormously important

because it affects not only the projects still to be accomplished, but it also affects the efficient use of the existing stock of capital. For example: suppose in the peace-time situation there are fishing boats from foreign countries on the inter-island sea, so the policy may increase the patrol ships to be purchased. This kind of policy will reduce the existing investment in armor or tank to defend against the demonstrations in some of the big cities.

3. Institutional

An institution must be chosen to be responsible for building and running any project. Sometimes the institution's technical and engineering outlook is not compatable with the objectives of the project. This condition sometimes leads the defence institution to become involved in investment projects which they do not believe in. The decision depends on general characteristics of these five defence institutions, for example: to purchase small arms (M-16) or the machinery to build this equipment. The top policy decisions were lead by the Army with some information requested from the other institutions.

4. Technical

Given the purpose of the project then technicians can design alternative means of achieving it. Technical information has more important implications for the "technical design of project". If the project as designed by the technicians cannot be justified, then it needs to be redesigned.

B. DEFINE PROJECT INITIATION

In the economic point of view to distinguish a project from other activity it is defined as a project of a one-time and non-routine activity, for example, building a railway is a project. But running the railway once it is built is not a project. To achieve its purpose, a project usually combines many separate elements. For instance: an industrial project requires a market of appropriate size to justify its construction. Building an airport base for the Air Force requires that the defence and security strategy be stated.

The creation of projects takes place over a considerable period of time. There are certain phases of this process:

1. Identification

Projects may be identified in an ad hoc manner to meet an obvious deficiency of supply, for instance: a project to meet the shortage of patrol boats in the country.

2. Preparation

Preparation usually required that a team of experts should work on alternative project design to the point where their relative technical capability and cost can be analyzed and tested. In some cases this may require that most of the engineering or other technical work be done prior to analysis.

3. Approval And Analysis

If the analysis yields favorable results the authorities concerned should give their approval to the project. In principle the central planning authority will have to give its final approval, particularly if the availability of financing for the project depends on that approval.

4. Financing

Once approval has been given to the project, its financing has to be found. This may involve the coordination of financing from variety of sources, for instance: a defence utility project may be able to receive a contribution from the national government plus a foreign loan. Arrangements for financing take time and may also have influence on project design. The kind of financing available can also affect project cost and design if foreign material is provided.

5. Implementation

Once the financing is arranged, the project can be carried out. The implementation process has to be carefully planned and scheduled. It is important for the manager/project officer to find a way of rational project scheduling, for example using Pert network or Critical Path Method. In general, the process involves planning, scheduling, procurement of project inputs and supervision.

6. Operation

Whether the favorable results of the final economic analysis are realized in practice will depend to a large extent on the quality of the management operating the project. The projects which yield favorable results in prior analysis. usually does so on the assumption of a certain level of skill and competence in operation. If the project preparation has been well done, it will take account of the competence of the officer of the operating agency.

C. INVESTMENT DECISION RULE

Some difficulties face the practical decision maker choosing among the investment opportunities for his institution. The greatest difficulty is lack of certainty about the true costs and benefits attached to each of the courses of action available. Problems are posed for investment choice by the elements of risk, ignorance and uncertainty. In general it is not true that investment opportunities can be uniquely ranked. The desirability of any one may be affected by the other projects. If the decision maker knows the correct set of projects to be adopted then there is no need to rank them in order of desirability. So therefore, we eliminated the ranking rules and limited attention to adoption rules or "criteria". A criterion is some mathematical formula computed on the elements of cost and benefit. A rule indicates the acceptability of a project by directing a comparison on the criterion computed, for example: adopt if the present value is greater than zero.

1. Discounted Present Value [7]

The adoption criterion most often used is "Present Value" or "Present Worth". This statement depends on time series of input and output. The present value of each element is calculated by multiplying it by a "DISCOUNT FACTOR - d" that applicable to period - 1, briefly these are:

a. Discount Factor

$$d_i = \frac{1}{(1 + r)^i}$$

For the initial input $d_o = 1$, i = 1,2.....,n

b. Discounted Present Value (=DPV)

For the discount present value of the investment cost, given by:

$$DPV = \sum_{i=0}^{n} \frac{C_i}{(1 + r)^i}$$

2. The Investment Criteria

There are six criteria to describe the purposes of investment, that are:

a. DPV of Net Benefit Flows (=NPV)

$$\sum_{i=0}^{n} \frac{Bi - Ci - Ki}{(1 + r)^i}$$

b. Internal Rate Of Return (=IRR)

IRR = r* When: NPV = 0

$$-K + \sum_{i=0}^{n} \frac{Bi - Ci}{(1 + r)^i} = 0$$

c. Benefit Cost Ratio (=B/C)

$$B/C = \sum_{i=0}^{n} \left(\frac{Bi}{(1 + r)^i} \right) \Big/ \left(\frac{Ci + Ki}{(1 + r)^i} \right)$$

d. Net Benefit Cost Ratio (= Net B/C)

$$\text{Net } B/C = \sum_{i=0}^{n} \left(\frac{Bi - Ci - Ki}{(1 + r)^i} \right) \Big/ \left(\frac{Bi - Ci - Ki}{(1 + r)^i} \right)$$

Positive Component / Negative Component

This means that after computing $\frac{Bi - Ci - Ki}{(1 + r)^i}$ for each year, net benefit cost ratio is the ratio of the sum of all positive values of annual discounted net benefit flows to the sum of all negative values of annual discounted net benefit flows.

e. Profitability Ratio (=PR)

$$PR = \sum_{i=0}^{n} \left(\frac{Bi - Ci}{(1 + r)^i}\right) \Bigg/ \left(\frac{Ki}{(1 + r)^i}\right)$$

f. Least Cost Method

Choose the project where $\sum_{i=0}^{n} \frac{Ci + Ki}{(1 + r)^i}$ is the lowest, with the same benefits for each alternative.

Where: B = Benefits per year

C = Operating and maintenance cost

K = Fixed and working capital

r = Rate of interst

i = Period of Time

n = Number of years required to finish the project

r*= Expected return of the rate of interest.

All criteria except for the least cost method can be used to determine "go" or "no go" decision for the project.

The way to use these will be described as follows:

-- Present value of net benefit flows. The net Present Value (NPV) criteria indicates the investment project should "go" if NPV $\geq$ 0. This also requires preliminary estimate of rate of interest "r".

-- Gross Benefit Cost Ratio. To decide the project "go" the gross B/C ratio must indicate B/C $\geqq$ 1.0. If NPV = 0 gross B/C = 1.0. In some cases gross B/C ratio rations total expence (not capital) because it is sensitive to the ratio of current costs to gross benefits. It can discriminate against those projects with a large volume of output but a small profit margin as compared with those projects that give a higher per unit profit margin and small volume.

-- Net Benefit Cost Ratio. To decide the project "go" the criteria must give: Net B/C ratio $\geqq$ 1.0. For NPV = 0 gives Net B/C = 1.0.

This investment rule will be appropriate for the long time period of the project. All increment cost could be considered as an investment and all incremental benefits as benefits.

-- Internal Rate Of Return (=IRR). The advantage of IRR is that it can be calculated without any prior judgement as to the level of the rate of interest. The signal to decide the project to be accomplished is IRR $\geqq$ OCC (opportunity cost of capital). Some one must make a decision to find the minimum IRR which would signify project acceptance. The disadvantages of IRR is the implicit assumption that all net benefits, through either consumption or reinvestment, yield the same rate of return as the IRR compounded through out the remainder

of the projects life time. This contradicts the assumption implied in the NPV criterion that at the margin, resources can bring consumption or reinvestment returns yielding only a rate of return equal to the social discount rate. If significant benefit occurs early in the project's lifetime, and the indicated IRR is appreciably above the social discount rate, it is likely that the IRR exagerates the project's profitability and could be misleading.

-- The Profitability Ratio.(P.R.) This ratio distinguishes between capital and current cost and this is an advantage to those wishing a criterion providing a degree of flexibility in interpretation of the term investment. To go for the investment project the decision rule will be P.R. $\geq$ 1.0. The interrelationship will give P.R. = 1.0, if N.P.V. = 0.0.

These above investment decision rules will be useful if we assume the benefit can be measured in Rupiahs. Another set of decision criteria involve methods which consider non-comparable benefits and cost.

D. LEAST COST METHOD

In the public sector especially in defence institutions, this criterion is often the most important. The least cost procedure indicates that the one mutually exclusive project with the lowest discounted net cost is prefereable if there is equal effectiveness for all projects. Often defence

institution investment projects have non-available information for the benefits. This discounted net cost includes R&D costs, working capital and operation and maintenance cost. Also preliminary estimate of interest rate is needed. The selected project must have the lowest discounted cost. However, whether the project is judged to meet the minimum return requirement, must be left to other criteria.

E. CAPITAL BUDGETING METHOD

The investment criteria and least cost method above are concerned with choosing an alternative from mutually exclusive projects. But in the capital budgeting method we can combine several objectives or the effectiveness of several projects and choose the maximum overall effectiveness subject to the constraint of any cost structure. In this capital budgeting procedure there are three major parts [11]:

1. Capital Budgeting Under Certainty

In this case all models are constrained maximizations and the benefits can be measured in rupiahs or in some measure of effectiveness. There are a series type of models which are progressively more complicated:

a. Model One

If the investment i are known to exist and the following data are given, Cost = C_i, present value of benefit = B_i, number of items purchased = X_i of any investment within resources = R.

The problem can be set up:

$$\text{MAX:} \quad \sum_{i=1}^{n} X_i \cdot B_i$$

$$\text{S.T:} \quad \sum_{i=1}^{n} X_i \cdot C_i \leq R$$

To solve this problem form: B_i/C_i and select the maximum B_j/C_j and also decide to buy R/C_j of this investment with the highest benefit-cost ratio.

b. Model Two

For the same data as model one above, but there are N_i of each investment available. Then the problem is set up as:

$$\text{MAX:} \quad \sum_{i=1}^{n} X_i \cdot B_i$$

$$\text{S.T:} \quad \sum_{i=1}^{n} X_i \cdot C_i \leq R$$

$$X_i \leq n_i \text{ for all } i$$

To solve this case order the B_i/C_i and then buy n_j items starting with the maximum ratio B_j/C_j and work down the list buying the allowed number until the budget runs out.

c. Model Three

For the same data as model two above, but in this model only integer numbers of each investment are allowable. Then the problem sets up:

$$\text{MAX:} \quad \sum_{i=1}^{n} X_i \cdot B_i$$

$$\text{S.T:} \quad \sum_{i=1}^{n} X_i \cdot C_i \leq R$$

$$X_i \leq n_i \text{ for all } i$$

X_i is integer

A solution to this problem can be obtained by linear programming and rounding. Small problems can be handled by integer programming techniques.

d. Model Four

For the same data as model two above, except additional investments are also required in period 2 in amount T_i each and the budgets are R_1 in period 1 and R_2 in period 2. Then the problem set up:

$$\text{MAX:} \quad \sum_{i=1}^{n} X_i \cdot B_i$$

$$\text{S.T:} \quad \sum_{i=1}^{n} X_i \cdot T_i \leqq R_1$$

$$\sum_{i=1}^{n} X_i \cdot T_i \leqq R_2$$

$$X_i \leqq n_i \text{ for all } i$$

This problem can be solved by linear programming and this model can be generalized to include investments in various periods.

2. Capital Budgeting Under Risk

In this type problem the present value of benefits are usually not known with certainty. Suppose there are two investments which are statistically independent. Then the choice of investment might be clear if one has a higher mean and a lower variance. But if this does not happen then some trade-off of mean versus variance may be necessary.

Such cases may be neglected for purposes of this thesis. The best estimate will usually be treated as certainty.

3. Capital Budgeting In Department Of Defence

This type of method is used in U.S. Department of Defence and important also in Indonesian defence institution investment decisions. The characteristics of simplified models of these procedures are as follows:

-- Since benefits stream (B) that contribute to national security are not commensurable with cost (C), we will be dealing with constrained optimization.
-- In general, security is measured relative to the threat (T), which is multidimensional to correspond to threats and dynamic to allow for future budgets.
-- Time discounting may be related to strategy if the present is most important.
-- Measurement of benefits, costs of investment and the threat is uncertain.

In this method there are two kinds of formulation.

a. Force Sizing Model

This model given by U.S. Secretary of Defence McNamara who set up the problem as a minimum cost over Five Year Defence Program.

MIN: $\sum_i C_{it} \cdot X_{it}$, for all time t

S.T: Mission-1: $B_{it} \cdot X_{it} \geqq T_{1t}$, for all time t

Mission-2: $B_{it} \cdot X_{it} \geqq T_{2t}$, for all time t

. . .

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Mission-n: $B_{it} \cdot X_{it} \geqq T_{nt}$, for all time t

If there is uncertainty in assessing the balance of forces for a mission area, this can be expressed in the constraint as:

$$\text{Prob.} \left(\sum_t \sum_i B_{it} \cdot X_{it} \geqq \sum_i T_t \right) \geqq R_t$$

Where: t = Period of forces

i = Number of forces

B = Benefit or effectiveness stream from each force

T = Threat in each mission area

R = Risk level desired for each mission area.

This formulation can not be decentralized because of uncertainty in measuring Prob. $\left(\sum_t \sum_i B_{it} \cdot X_{it} \geqq \sum_i T_t \right)$ and articulation of R_t .

b. Constrained Budget Model

This model given by Secretary of Defence M. Laird is formulated as:

MAX: $\sum_i B_{it} \cdot X_{it} - T_t$, for all time t

S.T: Mission-1: $\sum_i C_{it} \cdot X_{it} \leqq G_1$, for all time t

Mission-2: $\sum_i C_{it} \cdot X_{it} \leqq G_2$, for all time t

. . .

. . .

. . .

Mission-n: $\sum_i C_{it} \cdot X_{it} \leqq G_n$, for all time t

Where: t = Period of time

G = Budget for each mission at time t

C = Cost for each mission at time t.

The difficulties of this formulation will be stated as:

-- Since the Benefit, Threat and Risk level are vectors, then the vector of net benefit must be "maximized" and someone must establish priorities or weightings to the elements of the vector. In practice some elements are given priority.

-- Someone must establish the budget at time t and allocate the budget to the five services. This might be done by a force sizing sensitivity study. Suppose given a budget, we measured the threat (T) and allocated cost (C) to obtain the risk vector of Prob. $\left(\sum_t \sum_i B_{it} \cdot X_{it} \geqq \sum_i T_t \right) = R_t$ by mission type and area. If the R vector is not high enough to make the government secure, increase the budget and try again.

-- Once the budget is established, decentralization will require the matching of the forces and threats within the service, and the services have an allocation procedure:

MAX: $\sum_i B_{it} \cdot X_{it} - T_t$, for all time t

S.T: Mission-1: $\sum_i C_{it} \cdot X_{it} \leqq G_1$, for all time t

Mission-2: $\sum_i C_{it} \cdot X_{it} \leqq G_2$, for all time t

. . .

. . .

. . .

Mission-n: $\sum_i C_{it} \cdot X_{it} \leqq G_n$, for all time t

Where: t = Period of time

i = Number of forces

B = Benefit or effectiveness steam from a force

T = Threat for each mission area

C = Cost for each mission at time t

G = Budget for each mission at time t

Again the priority or weighting of mission must be decided.

According to all these methods it is most concerned with the benefits or effectiveness and the cost of projects for a period of time. The next chapter will be concerned with the benefits of investment for any project.

III. EVALUATION ON BENEFIT OF INVESTMENT

The process of benefits evaluation will deal with certain steps: (1) Use a systematic procedure to establish the benefit, trying to minimize subjective judgement. (2) Search, discover and record all the benefits, whether or not quantifiable, that are relevant for each alternative. (3) If possible express all the benefits for each alternative in terms of score, dollar, rupiahs, etc. (4) Arrange benefits according to some hierarchy of value if a common denominator is not available.

In the procedure of objective benefit determination there are four steps:

A. DEFINE THE RELEVANT BENEFIT

Determine the benefits of each alternative whether the benefit is potentially quantifiable or not. The following characteristics can be reviewed when listing and defining benefits:

1. Discreteness

Clarify and concisely identify all of the benefits. Make sure the measurements do not overlap and duplicate. Maintain as separate an entity as is possible.

2. Quantification

Measure both the direct benefit and indirect benefit. Use valid techniques in analysis, such as statistical methods.

3. Discrimination

The decision maker will find that the expected benefits of any alternative may fall into various categories depending on the program, system and operations, etc.

Some of the categories under which benefits could be applicable depending on the problem, are:

-- Production. Number of commodities or items and service produced from each alternative.
-- Productivity. Number of item or commodities per man hour. The volume of output related to the manpower.
-- Operating Efficiency. The operating efficiency is concerned with the rate that the svstem consumes resources to achieve the output.
-- Reliability. This describes the system in terms of its probability of failure.
-- Accuracy. Measurement of error per operating period of time.
-- Controlability. Adequate human performance engineering. System compatibility with trained crew member. If the system fails, find better way to repair or fix it.
-- Manageability. Consider whether the workload of the organization will be increased or decreased in terms of supervision or inspection time.
-- Integratability. Consider the workload and product of the organization will be affected by the changes in modification of equipment, technical data required, initial personnel training, etc.

-- Initial Availability. Time for each system to be delivered implemented, and used models are sometimes useful.
-- Service Life. The length of the period of proposed system will affect the organization workload or output.
-- Quality. Measure quality of services to be obtained, may use quality control theory.
-- Acceptability. Consider the alternative in terms of whether it may interfere with the operation.
-- Ecology. Consider the ecological aspect such as current legislative requirement for each alternative.
-- Economic. Consider employment benefits, business obligation or infrastructure and economically depressed area relationship.
-- Morale. Employee morale to be measured by opinion sample survey.
-- Safety. List the number of hazards involved.
-- Security. Measure the security built in and whether more precautions preserved are necessary.

B. DETERMINE THE SOURCE OF INFORMATION

Regarding the source of information about benefits there are three parts:

1. Benefits With Available Information

List each benefit and indicate source of information available for specific form. For each benefit proposed gather the needed information for the feasibility and quantifiable.

2. Benefits With The Information Not Available

The benefits with no information sources available must be recorded and identified. Research tasks to obtain information for the benefit determination must be defined and performed.

3. Benefits With Some Information Available And Some Not

Dealing with these cases most calculation concern is with the commonsense for the benefit with the information not available. To get all this information on the benefit one must collect data, provide sampling techniques and study in the library to find the sources for the relevant input. Public agencies, private firms and institutions can be helpful.

C. COLLECTION OF INFORMATION FOR BENEFIT DETERMINATION

Organize the method for collecting information for each benefit and record the information. It is to be emphasized that the disciplines concerned with formulating quantifiable and non-quantifiable outputs for analysis purposes must cooperate if adequate benefit determinations are to be established. For this list of information try to set up the tables in form that is easy to look at, Table 1 for example.

D. EVALUATION AND PRESENTING OF BENEFITS

There are some techniques available for comparing quantifiable benefits, for example: graphical analysis (consists of quantity versus defence capability or quantity versus personnel supported etc.) regression analysis (consists of the relationship between the benefit and the explanatory variable, etc.).

TABLE 1

INFORMATION OF NON-QUANTIFIABLE AND QUANTIFIABLE BENEFITS OF SMALL ARMS

BENEFITS OR EFFECTIVENESS	MEASURES OF QUANTIFIABLE AND NON QUANTIFIABLE	ALTERNATIVES		
		M16-A1 (U.S.A.)	G3 (GERMAN)	FN-FAL (BELGIUM)
PRODUCTION	UNIT/DAY	1000	900	950
RANGE EFFECTIVE	METER	400	500	500
MUZZLE VELOCITY	METER/SECOND	990	780	850
WEIGHT	KILOGRAM	3.18	4.3	4.3
CHARACTERISTIC				
TEMPERATURE RESISTANCE	BEND TEST	BETTER	GOOD	GOOD
IN SALT WATER	FLOATING	GOOD	SINK	SINK
CALIBRE	MILLIMETER	5.56	7.62	7.62
ETC.	-	-	-	-

NOTE: Some of this data comes from "BRASSEY'S INFANTRY WEAPONS OF THE WORLD 1979".

The composite of total worth or value of a non-quantifiable benefit can be seen in Table 2. The berthing facilities would be available to non-Navy users and the benefit of this is really unknown but can be measured by ships/day. For the communication facilities some of the station can't be used for rentals. For security resources or the storage/warehousing some of the stations have facilities available to rent which can be measured as unit inventory/day. For housing and facilities some of the station is rented by non-Navy users only.

TABLE 2

INFORMATION OF NON QUANTIFIABLE BENEFIT
OF NAVAL STATION TO NON NAVY USERS

BENEFITS	MEASURE OF NON QUANTIFIABLE BENEFIT	ALTERNATIVES		
		STATION A	STATION B	STATION C
1. BERTHING FACILITIES	NUMBER OF NON NAVY SHIPS/DAY	RENT	USE FOR UTILITIES ONLY	NOT FOR RENT
2. COMMUNICATION FACILITIES	COST/MESSAGE	NOT FOR RENT	NOT FOR RENT	LOCAL COMMUNICATION AVAILABLE
3. STORAGE/WAREHOUSING	UNIT INVENTORY/DAY	RENT	SMALL STORAGE FACILITY AVAILABLE	RENT
4. HOUSING AND FACILITIES	BUILDINGS/YEAR	LIMITED RENTALS AVAILABLE	RENT	RENT
ETC.	-	-	-	-

IV. EVALUATION OF COST FOR INVESTMENT

To analyze the cost of defence institution investment project it will be valuable to concentrate on determining the cost of discrete alternatives.

A. INPUT COST STRUCTURE

In the cost structure approach there are three cost categories, that are:

1. Research And Development Cost

The resources required to develop the new capability to the point of operational inventory at some desired level of reliability.

2. Investment Cost

The investment cost is concerned with one time outlays required to introduce the capability into the operational activities.

3. Operating And Maintenance Cost

This operating and maintenance cost is recurring outlays required per year to operate and maintain the capability in service over a period of time.

According to this cost structure for any decision alternatives can be compared by total system cost. This total system cost are defined as follow:

Total Cost/Period = Cost R & D + Cost of Investment + Cost of operating and maintenance.

B. COST ESTIMATING METHOD

In this cost estimating method there are two methods for conducting the cost estimation.

1. Industrial Engineering Method

This method consists of a consolidation of estimates from various separate work elements in a total project cost estimate. This total cost system is defined as:

$$\text{Total Cost} = \sum_{i=1}^{n} P_i \cdot Q_i$$

Where: TC = Total Cost

P = Price for each item or equipment

Q = Quantity for each item or equipment

i = Number of item or equipment

2. Parametric Cost Estimating

This cost approach uses the statistical model and therefore requires historical data of similar systems. This cost system is defined as follows:

Cost/unit = f (physical or performance characteristic of the system).

The statistical analysis can help to provide an understanding of factors that influence the cost. This characteristic of the cost factor is concerned with the regression analysis, that is, the relationship between cost and the explanatory variables.

The equation of simple model is linear equation:

$Y = a + b.X$

Where: Y = Cost (Dependent variable)

X = Characteristics of explanatory variables

a = Estimated constant of cost

b = Estimated coefficient of cost per unit of characteristic.

To derive these parameters a and b the standard approach is the "Least Square Method". This method for total cost system is defined as shown in Appendix A.

C. COST VERSUS QUANTITY RELATIONSHIP

In this cost evaluation related to quantity of items produced or purchased, there are two types of methods:

1. Cumulative Learning Curve

This learning curve theory is to predict reductions in cost as the number of items produced increases. The basis of this theory is that each time the total quantity of items produced doubles, the cost per item is reduced to a constant percentage of its previous cost, for example: If the cost of producing the X^{th} unit of item is 80 percent of the cost of producing X/2 items, this is called an 80 percent unit learning curve. If the average cost of producing all Y units is 75 percent of the average cost producing the first Y/2 units this will be called a 75 percent cumulative average learning curve. So the cost of producing quantity of items will be based on percentage of the learning curve.

2. Short Run Fixed And Variable Cost

In the case of defence support cost, usually stated as: support cost = f (forces support) or S.C = a + bX

Where: S.C = Support Cost

a = Constant of the fixed cost

b = Coefficient of the variable cost.

X = Forces support

The most important use in defence institution in the support cost is to maintain the routine activity and tasks on any base. The next chapter will be concerned with investment organization in Defence Institution.

V. INVESTMENT ORGANIZATION IN DEFENCE INSTITUTIONS

To determine the cost and benefits of discrete alternatives for any investment project in the public sector, especially in defence institutions, there are two kinds of investment decisions: First mutually exclusive projects, which means that there are two or more projects and only one project can be chosen. Second multipurpose projects, which means that there are two or more projects that will be served by one alternative.

In general, the investment for defence institutions is concerned with the four branches of organization, that are: Personnel Department, Material Department, Financial Department, and Operational Department.

Each department is responsible for its own investment program and each department may be part of one of the five parts of armed forces organization:

A. DEPARTMENT OF DEFENCE

Dealing with investment programs there are in general several types of equipment for investment:

- -- Equipment for communication, command and control for the armed forces.
- -- Equipment or tooling instruction in educational field for armed forces.
- -- Equipment and tooling for defence regular base.
- -- Transportation equipment.
- -- Medical equipment.
- -- Warehousing, etc.

B. DEPARTMENT OF ARMY

Dealing with Department of Army investment program there are several types of equipment for investment:

-- Equipment for communication and control.
-- Equipment for weapon systems such as: gunnery (small arms), armor, tank, artillery, helicopter/aircraft, etc.
-- Equipment for regional Army base, such as: repair equipment, construction equipment and others.
-- Equipment and tooling for R & D and computer department.
-- Equipment and tooling for education and training in Army field.
-- Medical equipment and others.

C. DEPARTMENT OF NAVY

Dealing with the Department of Navy investment program there are some types of equipment for investment:

-- Equipment for communication and control on the ship and bases.
-- Equipment for the Navy weapon system, such as: ship and patrol boat, defence gunnery, dockyard and replacement equipment, patrol aircraft and helicopter, etc.
-- Equipment for the NAVAL district and bases, such as: repair equipment for support Naval bases, construction of housing on the base, dockyard equipment and others.
-- Equipment and tooling for education and training.
-- Equipment and facilities for R & D and computer.
-- Medical equipment, warehousing and others.

D. DEPARTMENT OF AIR FORCE

Dealing with the Department of Air Force investment program there are several types of equipment for investment:

-- Equipment for communication and control.
-- Equipment for the Air Force weapon systems, such as: squadron of defence aircraft, squadron of defence transport aircraft, defence gunnery (small arms), cargo handling equipment and replacement facilities.
-- Equipment for the Air Force district, such as: construction landing Air Base, repair equipment on Air Base, construction of housing facilities and others.
-- Equipment and tooling for education and training.
-- Equipment for R & D and computer facilities.
-- Medical equipment, warehousing and others.

E. STATE POLICE DEPARTMENT

Dealing with State Police Department investment program there are several types of equipment or facility:

-- Equipment for communication and control for police activity and investigation.
-- Facility for small arms gunnery.
-- Equipment for R & D and computer facilities.
-- Transportation and medical equipment and warehousing, etc.

From the benefits point of view, most of defence institution project dealing with the cases of information available or some have information not available. The next chapter will deal with presentation of the result for these four methods.

VI. PRESENTATION OF RESULTS

The purpose of investment project is to compare the alternatives and identify which is the better to be accomplished. In order to choose any alternative this thesis gives four types of methods.

A. INVESTMENT CRITERIA (COMPARABLE BENEFITS AND COST)

In this case the result of each criteria will compare the alternative to be used or accepted, for example: assume two independent projects. Both projects have a life time of 20 years and investment of Rp. 40 million in the first year and have no salvage value at the end of 20 years life. Project A has gross annual costs starting in year 2 through 20 of Rp. 40 million and gross annual benefits over the same period of Rp. 52 million, starting in year 2 and continuing through year 20. Project B has gross annual cost of Rp. 2.8 million and gross annual benefits of Rp. 10 million.

Assume a discount rate of 15%, to compute all the investment criteria. To solve this investment problem the computation will be given in Table 3 and Table 4.

This computation will give: Gross B/C, Net B/C, Profitability Ratio and Internal Rate of Return. Table 5 will summarize the result of this computation [2] on Project A and B.

TABLE 3

PROJECT - A (IN MILLIONS RUPIAH)

YEARS	DISCOUNTED FACTOR AT 15%	BENEFITS	COST AND INVESTMENT	NET BENEFITS	NET PRESENT - VALUE AT 15%
1	0.870	0.0	40.0	- 40.0	- 34.80
2 - 20	5.390	52.0	40.0	12.0	64.68
TOTAL:	6.260	52.0	80.0	- 28.0	29.88

NOTE: Calculate the Investment Criteria.

1. GROSS B/C $= \frac{280.28}{250.40} = 1.12$

2. NET P.V. $= 29.88$

3. NET B/C $= \frac{64.68}{34.80} = 1.86$

4. P.R. $= \frac{64.68}{34.80} = 1.86$

5. I.R.R. $= r_1 + \frac{P.V_1}{P.V_1 - P.V_2}\ \% = 29\% + \frac{0.815}{0.815 + 0.215}\ \% = \underline{\underline{29.79\%}}$

TABLE 4

PROJECT B - (IN MILLIONS RUPIAH)

YEARS	DISCOUNTED FACTOR AT 15%	BENEFITS	COST AND INVESTMENT	NET BENEFITS	NET PRESENT - VALUE AT 15%
1	0.870	0.0	40.0	- 40.0	- 34.80
2 - 20	5.390	10.0	2.8	7.2	38.81
TOTAL:	6.260	10.0	42.8	- 32.8	4.01

NOTE: Calculate the Investment Criteria.

1. NET P.V. = 4.01

2. GROSS B/C $= \frac{53.90}{49.092} = 1.08$

3. NET B/C $= \frac{38.808}{34.800} = 1.12$

4. P.R. $= \frac{38.808}{34.800} = 1.12$

5. I.R.R. $= r_1 + \frac{P.V_1}{P.V_1 - P.V_2}\% = 17\% + \frac{0.178}{0.178 + 1.460}\% = \underline{\underline{17.109\%}}$

TABLE 5

RESULT OF PROJECTS A AND B

INVESTMENT CRITERIA	PROJECT A	PROJECT B
1. NET PRESENT VALUE	29.88	4.01
2. GROSS B/C	1.12	1.08
3. NET B/C	1.86	1.12
4. PROFITABILITY RATIO	1.86	1.12
5. INTERNAL RATE OF RETURN	29.79%	17.109%

Looking at the result in Table 5, the better alternative is to choose Project A.

B. COST STRUCTURE METHOD

To compare the alternatives it must be considered to have the equal effectiveness. Suppose the Navy Planning Department will decide to choose two from three naval stations for a Navy district, suppose station A, B and C. Based on the operational and patrol activity each station must have: berthing facilities, communication facilities, medical and dental facilities, warehousing/storage facilities, small repair and maintenance facilities and office/administrative housing facilities. So if these Naval Stations have this same capability to support Naval operational and patrol activity then the problem for investment is to decide the cost structure for the twenty years period. Assume that this decision can be made without an influence of geographical and tactical planning.

Suppose given the data in Table 6, then find the decision which Naval station will be run.

TABLE 6

INVESTMENT AND TOTAL COST PER YEAR OF ESTABLISHING THREE NAVAL STATIONS (IN MILLIONS RP)

COST - ITEMS	STATION A	STATION B	STATION C
INVESTMENT			
1. Berthing	400	100	200
2. Communication	1000	800	500
3. Medical & Dental	30	30	50
4. Storage	30	20	50
5. Maintenance & Repair	500	300	500
6. Housing/Office	100	50	150
	2060.0	1300.0	1450.0
OPERATION & MAINTENANCE			
1. Operating and Training	50	40	30
2. Maintenance and Repair	100	70	100
3. Pay & Allowens	70	70	60
	220.0	180.0	190.0

To calculate the Least Cost of discount present value will be given in Table 7 - and the decision will be Naval station B and station C.

TABLE 7

DISCOUNT PRESENT VALUE FOR THE PROJECT
A, B AND C (IN MILLIONS RUPIAH)

YEARS	DISCOUNTED FACTOR AT 15%	INVESTMENT AND COST			DISCOUNTED PRESENT VALUE AT 15%		
		STATION A	STATION B	STATION C	STATION A	STATION B	STATION C
1	0.870	2060.0	1300.0	1450.0	1792.20	1131.00	1261.50
2 - 20	5.390	220.0	180.0	190.0	1185.80	970.20	1024.10
TOTAL:	6.260	2280.0	1480.0	1640.0	2978.00	2101.20	2285.60

NOTE: From this D.P.V. of cost for each NAVAL Station the result:

1. NAVAL Station A:: Rp. 2978.00
2. NAVAL Station B: Rp. 2101.20
3. NAVAL Station C: Rp. 2285.60

So the ranking for this investment opportunity will be: Station B, Station C and Station A.

C. EVALUATION OF COST ESTIMATION

In this cost estimation problem, suppose the investment in defence institution required to build the Patrol Frigate ship from Netherland (Frigate - I) or from Italy (Frigate - II) with the cost of bidding defined as follows:

Frigate - I, number :	1	2 & 3	4
Cost of bidding (In million rupiah) :	100	180	80

Frigate - II, number:	1	2	3 & 4
Cost of bidding (In million rupiah)	100	90	165

To solve this learning curve problem for instance, assume the defence planning department decided that these two frigates have equal effectiveness although there are differences in size and armament. To find the unit cost for Frigate - I in lot 2 and Frigate - II in lot 3, we can use logarithmic paper for the learning curve by inspection or use learning curve formula as stated in Appendix A. For example calculation for unit cost of Frigate - II in lot 3 will be:

$Y_u = a.X^b$

given: $Y_2 = 90$

$a = 100$

$X = 2$

$90 = 100 \cdot 2^b$

$b = \frac{\log 0.9}{\log 2} = -0.152$

So the unit cost for 3 and 4 Frigate - II in lot 3 are equal to:

$$Y_3 = 100 \cdot 3^{-0.152} = 84.0$$

$$Y_4 = 100 \cdot 4^{-0.152} = 81.0$$

For this same idea we compute also the unit cost of Frigate - I in lot 2:

Given: $Y_4 = 80$

$a = 100$

$X = 4$

$$80 = 100 \cdot 4^{b}$$

$$b = \frac{\log 0.8}{\log 4} = -0.161$$

The unit cost for 2 and 3 Frigate - I will be equal:

$$Y_2 = 100 \cdot 2^{-0.161} = 90 \quad (51.73\%)$$

$$Y_3 = 100 \cdot 3^{-0.161} = 84 \quad (48.27\%)$$

Approximately: $Y_2 = 0.5173 \cdot 180 = 93.11$

$Y_3 = 0.4917 \cdot 180 = 86.89$

Then the result of unit cost, cumulative cost and cumulative average cost will be shown in Table 8. The result of this Table will conclude that if the budget is available to purchase two, three or four ships then the alternative is to choose Frigate - II.

TABLE 8

RESULT OF ESTIMATING COST FOR TWO
TYPES OF FRIGATES (IN MILLIONS RUPIAH)

TYPES OF SHIPS	LOTS	QUANTITIES	CUMULATIVES QUANTITIES	UNITS COST	CUMULATIVES COST	CUMULATIVES AVERAGE COST
FRIGATE - I	1	1	1	100.00	100.00	100.00
	2	2	2	93.11	193.11	96.56
			3	86.89	280.00	93.33
	3	1	4	80.00	360.00	90.00
FRIGATE - II	1	1	1	100.00	100.00	100.00
	2	1	2	90.00	190.00	95.00
	3	2	3	84.00	274.00	91.33
			4	81.00	355.00	88.75

D. CAPITAL BUDGETING METHOD

This method for defence investment problems is a programming approach concerned with maximizing total number of output, subject to initial investment outlays and discounted present value of cost for the limited budget decision. Suppose the planning department needs to decide between investment in three projects (I, II and III). The benefits of these projects will be concerned with stability which includes the challenge of threats to the national security also assuming these three projects have equal benefits, and we will arbitrarily set the benefits only for one project.

Suppose the cost for investment can be described for two periods of time, as follows (in millions rupiah):

	Capital Investment	Period 1	Period 2
Project I	$K_1 = 50$	$C_{11} = 90$	$C_{12} = 80$
Project II	$K_2 = 100$	$C_{21} = 170$	$C_{22} = 160$
Project III	$K_3 = 60$	$C_{31} = 120$	$C_{32} = 110$

The initial budget investment given by G = 110, the budget for Period 1 is $H_1 = 210$ and the budget for Period 2 is $H_2 = 190$. This type of problem will be stated as follows:

$$\text{MAX:} \quad \sum_i X_i$$

$$\text{S.T.:} \quad \sum_i K_i \cdot X_i \leqq G$$

$$\sum_i C_{i1} \cdot X_i \leqq H_1$$

$$\sum_i C_{i2} \cdot X_i \leqq H_2$$

Where: i = For each project

K = Initial capital investment

C = Discounted Present Value of operating cost in each project for each period

G = Budget constraint for initial investment

H = Budget available for the cost in each period.

The solution of this problem can be found for Projects I, II, and III to have the value of $X_1 = 1.0$, $X_2 = 0.0$, $X_3 = 1.0$ units and the total present value in Period 1 DPV of cost = 210.0 and in Period 2 the DPV of cost = 190.0. But if the decision has to choose Project II only, for Period 1 the cost = 170.0 and for Period 2 the cost = 160.0.

Projects I and III gives twice as much benefits than Project II. In general this method can be decided in several ways according to the minimizing cost with subject to constraint of any kind of effectiveness.

Further development of these methods for evaluating investment project in Indonesian Defence Institution, needs more concentration on the effectiveness of defence investment program. This program will be concerned with the budget constrained for each period of time. If the budget is available for each period of time then the defence investment program will reach the requirement for the national objectives and the security of the nation.

APPENDIX A

A. FORMULA FOR REGRESSION ANALYSIS

1. $$\hat{B} = (X^T \cdot X)^{-1} \; X^T \cdot Y = \begin{bmatrix} n & X \\ \sum X & \sum X^2 \end{bmatrix}^{-1} \cdot \begin{bmatrix} \sum Y \\ \sum X \cdot Y \end{bmatrix}$$

$$\hat{B} = \begin{bmatrix} \hat{a} \\ \hat{b} \end{bmatrix}$$

2. $$SE = \sqrt{\frac{\sum_{i=1}^{n} (Y_i - Y)^2}{n - 2}}$$

3. $$S_b = \frac{SE}{\sqrt{\sum_i (X_i - \bar{X})^2}}$$

4. $$t = \frac{\hat{b}}{S_b}$$

5. $$\bar{X} = \frac{\sum_{i=1}^{n} X_i}{n}$$

6. $$\bar{Y} = \frac{\sum_{i=1}^{n} Y_i}{n}$$

7. $$Y_1 = \frac{\sum_{i=1}^{n} (Y_i - \bar{Y})^2}{n - 1}$$

8. $$Y_2 = \frac{\sum_{i=1}^{n} (\hat{Y}_i - \bar{Y})^2}{n - 2}$$

9. $$Y_3 = \frac{\sum_{i=1}^{n} (Y_i - \hat{Y})^2}{n - 2}$$

10. $$C V = \frac{S E}{\bar{Y}}$$

11. $$R^2 = \frac{(n - 1) \sum_{i=1}^{n} (\hat{Y}_i - \bar{Y})^2}{(n - 2) \sum_{i=1}^{n} (Y_i - \bar{Y})^2}$$

Where:

$\hat{B}$ = The vector of parameter estimate constant $\hat{a}$ and $\hat{b}$

$\bar{X}$ = Average explanatory variables

$\bar{Y}$ = Average cost

Y = Estimate of cost for each number of X_i

Y_1 = Total variance of Y

Y_2 = Explained variance of Y

Y_3 = Unexplained variance of Y

S E = Standard error

S_b = Standard error of b

t_b = t - ratio of the coefficient to its standard error

C V = Coefficient of variation

R^2 = Coefficient of determination

R = Correlation coefficient

B. FORMULA FOR THE LEARNING CURVE

1. $Y_u = a \cdot X^b$

2. $S = 2^b$ OR $b = \frac{\log S}{\log 2}$

3. $T_c = a \cdot \sum_{x=1}^{n} X^b$

4. $Y_c = \frac{T_c}{n} = \frac{a}{n} \sum_{x=1}^{n} X^b$

5. $T_c = Y_c \cdot X = a \cdot X^{b+1}$

Where:

a = Constant for the cost of first unit produced

b = The coefficient of the slope for the Learning Curve

S = The fraction to which cost decreased when quantity doubles

X = Cumulative production quantity

Y_u = Unit Cost

T_c = Cumulative cost

Y_c = Cumulative average cost

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